# DIALLEL ANALYSIS OF COMBINING ABILITY IN SOME FLAX GENOTYPES

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***Abstract***

In the present study consisted of six flax genotypes were crossed in a diallel mating design excluding reciprocals to obtain 15 $F_1$'s crosses. In 2005/06 seasons, the parents and their 15 $F_1$'s seeds were evaluated in a randomized complete block design with three replications at Giza Res. Station of the ARC to estimate combining ability and gene action for yield and yield components. Results obtained can be summarized as follow:

1- The ratio of GCA/SCA indicated that the non-additive effects were more important than additive effects for straw yield per plant whereas, the additive effects were more important than non-additive effects for plant height, technical length and no of basal branches per plant.

2- Some parent genotypes exhibited significantly positive GCA effects for straw yield, plant height and technical length indicating that the possibility of using these parents in flax breeding programs for improving straw yield per plant.

3- Three crosses exhibited significant positive SCA effects as well as, involved high x low general combiners for straw yield and most important components (plant height and technical length).

4- The ratio of GCA/SCA for seed yield, number of seeds per capsule and 1000-seed weight. revealed that the inheritance of these traits were mainly controlled by additive effects of genes. In contrast, the inheritance of no. of capsules per plant was mainly controlled by non-additive effects of genes.

5- One parent showed significant positive GCA effects for seed yield, number of capsules per plant and 1000-seed weight, whereas, three parents were good combiners for number of seed per capsule.

6- The cross $P_2xP_5$ exhibited significant positive SCA effects for both seed yield and no. of capsules per plant. This cross involved two parents of high GCA effects for capsules per plant and high x low for seed yield per plant. In contrast, three crosses exhibited significant positive SCA effects for seed yield and most of its important components and involved high x low general combiner parents.

7- Phenotypic and genotypic correlation coefficients among eight traits indicate that the flax breeder must give priority to selection for both increased plant height and number of basal branches to increase straw yield per plant, and both number of capsules and 1000-seed weight to improve seed yield per plant in flax.

Key words: *Diallel analysis, Combining ability, Gene action, Flax.*

## INTRODUCTION

Flax (*Linum usitatissimum* L.) is considered the second important fiber crop in Egypt after cotton and is grown as a dual purpose crop for both oil and fiber. Linseed, oil in the preeminent drying oil used in paints and as raw material for other important industrial products as well as, the flax plant was extensively used for the production of linen in Egypt and other ancient civilizations and is still used today. Singh *et al* (1987) relatively little is known regarding the development of desirable dual-purpose cultivars for oil and fiber

The diallel cross technique proposed by Griffing (1956) has been widely used for the evaluation of general combining ability (GCA) and specific combining ability (SCA). Recently, the use of diallel analysis for evaluating the potential of parents for producing desirable recombinations in self-fertilizing crops has been studied by several workers (Joshi and Dhawan, 1966 and Matzinger, 1963) inducing several investigations on flax. Information of the type of gene action involved in the expression of a character is helpful in deciding the breeding procedures to be used for improvement of the character and is necessary for efficient utilization of available germplasm in a plant breeding program. Combining ability analysis is the most widely used biometrical tool for classifying parental lines in terms of their ability to combine in hybrid combinations. With this method, the resulting total genetic variation is partitioned into the effects of general combining ability, a measure of additive gene action and specific combining ability, a measure of non-additive gene action. It is very essential that the breeder should evaluate the potentialities of the available germplasm for new recombinations and eventually combining ability have proved to be of considerable use in crop plants. In this regard, several studies have been reported in flax, i.e. Thakur *et al* (1987), Mishra and Rai (1996), Patil *et al* (1997), Foster *et al* (1998), Abo El-Zahab and Abo-Kaied (2000), Abo-Kaied (2002) and El-Refaie (2003).

The present investigation was designed to obtain information on the nature of gene action operating in the inheritance of yield and its different contributing traits in flax and estimate the phenotypic and genotypic correlations between yield and its related traits.

## MATERIALS AND METHODS

The materials used for the present study consisted of 6 parents viz., $P_1$ (Giza 8) and $P_2$ (S.402/1), $P_3$ (S.420/140/5/11), $P_4$ (S.421/43/14/7), $P_5$ (S.533/39/5/3) and $P_6$ (Daniela). Genotype characteristics of these parents and their pedigree, type (dual, oil, fiber type) and origin are presented in Table (1).

Table 1. Identification of parental genotypes used, pedigree, classification (dual, oil, fiber types) and origin.

| Genotypes | Pedigree | Type | Origin |
|---|---|---|---|
| $P_1$= Giza 8 | Giza 6 x Santa catalina 6 (I. Argentina) | dual | Local *cv.* |
| $P_2$= S.402/1 | Giza 5 x cv. I 235 (I.USA) | oil | Local strain |
| $P_3$= S.420/140/5/11 | S.162/12 x S.83/3 | dual | Local strain |
| $P_4$= S.421/43/14/7 | S.162/12 x S.6/2 | dual | Local strain |
| $P_5$= S.533/39/5/3 | S.420 x bombay (I. USA) | dual | Local strain |
| $P_6$= Daniela | An Introduction | fiber | Romania |

In 2004/05 season, the six parents were crossed in a diallel mating design excluding reciprocals to obtain 15 $F_1$ crosses. In 2005/06 season, the parents and their crosses were evaluated in the breeding nursery of the Fiber Crops Res. Section, ARC at Giza.

The experiment was laid out in a randomized complete block design with three replications with restricted randomization where each plot consisted of single $F_1$ row guarded by one row of its parents. Rows were 3 m long, spaced 20 cm apart. Single seeds were hand drilled in 10 cm spacing within rows. At harvest, individual guarded plants were taken at random from each row, 10 plants from each parent and $F_1$ per replication. These plants were used for recording: straw yield (g) / plant, plant height (cm), technical stem length(cm), no. of basal branches, seed yield (g) / plant, 1000-seed weight (g), no. of capsules / plant, and no. of seeds / capsule.

**STATISTICAL ANALYSIS**

Plot means were used for statistical analysis. General (GCA) and specific (SCA) combining ability sum of squareswere calculated according to Griffing's method 2 (parents and one set of $F_1$'s are included but not reciprocal $F_1$'s, i.e., (P (P+1)/2) combination, model 1 (fixed effects). Phenotypic ($r_p$) and genotypic ($r_g$) correlation coefficients were calculated following Al-Jibouri *et al.* (1958).

## RESULTS AND DISCUSSION

**Straw yield per plant and its components:**

Mean squares due to genotypes (6 parents and 15 $F_1$'s crosses) were significant for straw yield and its components viz., plant height, technical length and number of basal branches per plant (Table2). Also, general (GCA) and specific (SCA) combining ability variances for these traits were significant, indicating the presence of both additive and non-additive type of genetic variance.

The ratio of general to specific combining ability variances for straw yield per plant showed that the non-additive effects were more important than additive effects.

Although SCA mean squares were significant for plant height, technical length and no. of basal branches / plant, the magnitude of GCA mean squares were several times greater than SCA mean squares for these three components of straw yield. Therefore, the magnitude of additive genetic effects must be of considerable value for each character. Consequently, effective selection should be possible for these two traits within the $F_2$ and subsequent populations of the crosses. Similar results were reported by Singh *et al* (1987), Thakur *et al* (1987), Patil *et al* (1997), Foster *et al* (1998), Abo El-Zahab and Abo-Kaied (2000), Abo-Kaied (2002) and El-Refaie (2003).

**GCA effects**

The estimates of GCA effects are presented in Table 3. $P_5$ (S.533/39/5/3) showed high general combining ability for straw yield, plant height and technical length. The next high combiner was $P_4$ (S.421/43/14/7) for plant height and technical length, suggesting the importance of these two parents ($P_4$ and $P_5$) for increasing plant height and technical length as well as $P_5$ for improving straw yield per plant. Also, $P_1$(Giza 8) showed highly significant positive GCA effects for straw yield and no. of basal branches per plant, whereas, $P_3$ (S.420/140/5/11) showed highly significant positive GCA effects for technical length only.

The simple correlation between GCA values and parental means for plant height and technical length were significantly positive. Similar findings were reported by Abo El-Zahab and Abo-Kaied 2000 and Abo-Kaied 2002 in flax. These results indicated that the parents showing higher mean performance (Table 5) proved to be the highest general combiners for these two important components. Therefore, high mean performance of the parents could be transferred to hybrids in such cases.

**SCA effects**

Specific combining ability effects for straw yield per plant and its components in flax crosses are presented in Table 4. Out of the 15 $F_1$ crosses, only five crosses ($P_1\times P_3$, $P_1\times P_4$, $P_2\times P_6$, $P_4\times P_6$ and $P_5\times P_6$) showed highly significant positive SCA effects for straw yield per plant. Six crosses ($P_1\times P_4$, $P_1\times P_5$, $P_1\times P_6$, $P_2\times P_5$, $P_2\times P_6$ and $P_5\times P_6$) and four crosses ($P_1\times P_5$, $P_1\times P_6$ ,$P_2\times P_6$ and $P_5\times P_6$) also, showed high SCA effects in the desirable direction for both plant height and technical length, respectively. Three crosses ($P_1\times P_4$, $P_2\times P_6$ and $P_5\times P_6$) indicated highly significant positive SCA effects for no. of basal branches per plant. In general, one cross ($P_5xP_6$) exhibited significant and positive SCA effects for straw yield and its two components viz., plant height and technical length. Also, cross $P_1xP_4$ exhibited significant positive SCA effects for straw yield, plant height and No. of basal branches as well as, one cross ($P_1xP_5$) exhibited significant positive SCA effects for plant height and technical length. The crosses ($P_1xP_4$, $P_1xP_5$ and $P_5xP_6$ ) involved high x low general combiners for the above mentioned traits (straw yield, plant height and technical length). Therefore, these crosses are likely to throw good segregates for these traits if the allelic genetic systems are present in good combination and epistatic effects present in the crosses act in the same direction to maximize the desirable characteristics. Therefore, the crosses ($P_1xP_4$, $P_1xP_5$ and $P_5xP_6$ ) may prove useful for simultaneous improvement of the above-mentioned traits. These results indicated that the importance of epistatic effects in the genetic control of these traits. The correlation between cross means (Table 5) and their SCA values (Table 4) was significant and positive indicating that high performing crosses were high specific combinations. Therefore, the choice of promising cross combinations would be based on SCA effects or mean performance of cross.

**Seed yield per plant and its components**

Analysis of variance showed that mean squares due to genotypes, parents and crosses were highly significant for seed yield and its components viz., no. of capsules per plant, 1000-seed weight and no. of seeds per capsule (Table2). These results indicated that the parental genotypes and $F_1$ crosses showed reasonable degree of variability for these traits. Also, analysis of combining ability showed highly significant mean squares for both general and specific combining ability for all characters, revealing the important role of both additive and non-additive genetic effects in the expression of seed yield and its components. The ratio of GCA/SCA for seed yield (1.32), number of seeds per capsule (2.66) and 1000-seed weight (12.91) showed that the inheritance of these traits was mainly controlled by additive effects of genes. Oppositely, the GCA/SCA ratio for no. of capsules / plant indicates that this trait was mainly controlled by non-additive effects of genes. Thakur and Rana 1987, Abo El-Zahab and Abo-Kaied 2000 and Abo-Kaied 2002 reported similar results.

**GCA effects**

Estimates of GCA effects for each parent are presented in Table 3. The data indicated that $P_1$ (Giza 8) showed significant and positive GCA effects for seed yield and 1000-seed weight. $P_2$ (S.402/1) exhibited significant positive GCA effects for seed yield and two important components (no. of capsules / plant and 1000-seed weight), whereas, $P_3$ (S.420/140/5/11), $P_4$ (S.421/43/14/7) and $P_6$ (Daniela) were good combiners for number of seeds per capsule. In general, $P_2$ (S.402/1) proved to be a good combiner for most characters under study. Using such parents in varietal improvement programs may result in isolating desirable combinations of these traits. The simple correlation coefficient between GCA Values and parental means for number of seeds per capsule and 1000-seed weight were significantly positive. Similar findings were reported by Abo El-Zahab and Abo-Kaied 2000 and Abo-Kaied 2002 in flax.

These results indicated that the superiority of a parent in cross combinations could be directly predicted from its *per se* performance for the two traits:1000-seed weight and No. of seed / capsules.

**SCA effects**

Specific combining ability effects calculated for each cross are presented in Table 4. The data showed that five crosses ($P_1{\times}P_4$, $P_1{\times}P_5$, $P_1{\times}P_6$, $P_2{\times}P_5$ and $P_5{\times}P_6$) exhibited significant positive SCA values for seed yield per plant, five crosses ($P_1{\times}P_4$, $P_1{\times}P_5$, $P_2{\times}P_5$, $P_2{\times}P_6$ and $P_3{\times}P_6$) for number of capsules per plant, six crosses ($P_1{\times}P_3$, $P_1{\times}P_4$, $P_1{\times}P_6$, $P_3$ x$P_5$, $P_3$ x$P_6$ and $P_4{\times}P_6$) for 1000-seed weight and five crosses ($P_1$x$P_2$, $P_1$x$P_3$, $P_1$x$P_6$, $P_2$ x$P_3$ and $P_5$x$P_6$) for no. of seeds per capsule exhibited significant positive SCA values. In general, the cross ($P_2$x$P_5$) exhibited significant and positive SCA effects for both seed yield and no. of capsules / plant. This cross involved two parents of high x high GCA effects for no. of capsules / plant and high x low for seed yield/plant. In contrast, four crosses ($P_1$x$P_4$, $P_1$x$P_5$, $P_1$x$P_6$ and $P_2$x$P_5$) among high x low general combiner parents for seed yield / plant, three crosses ($P_1$x$P_4$, $P_1$x$P_5$ and $P_2$x$P_6$) for no. of capsules / plant, three crosses ($P_1$x$P_3$, $P_1$x$P_4$ and $P_1$x$P_6$) for 1000-seed weight and two crosses ($P_1$x$P_3$ and $P_1$x$P_6$) for No. of seeds / capsule.

Bhatade and Bhale (1983) suggested that for crosses exhibiting significant SCA effects which resulted from high × high good GCA combiners, such as the $P_2$x$P_5$ cross, breeding procedure which may make use of both additive and non- additive genetic variance would be more useful for improvement of character(s) involved. The available additive genetic variance should first be exploited by adopting mass selection in early generations, then some form of *inter-se* mating may be followed among elite selections in later generations, which may help in fixing non- additive effects.

The simple correlation between cross means and their SCA values was significant and positive indicating that the crosses showing higher mean performance (Table 5) proved to be the highest specific combiners for the respective characters. Therefore, the choice of promising cross combinations would be based on SCA effects or mean performance of the crosses.

**Correlation studies**

Phenotypic ($r_p$) and genotypic ($r_g$) correlation coefficients among eight traits in flax are shown in Table 5. Straw yield / plant was significantly positively correlated with each of plant height, no. of basal branches, seed yield and no. of capsules / plant. Also, a significant positive correlation between plant height and technical length was present, indicating that maximization of straw yield may be obtained by selection for these traits. Moreover, seed yield was significant positively correlated with the two components no. of capsules per plant and 1000-seed weight. On the other hand, 1000-seed weight showed negative correlation with no. of seeds / capsule indicating that number of capsules per plant and 1000-seed weight are main component for seed yield per plant. These results are in harmony with Momtaz *et al.*, 1977, Sabh,1989, and Abo El-Zahab *et al*,1994. these results indicated that number of capsules per plant and 1000-grain weight are main components for grain yield per plant.

## CONCLUSION

The magnitude of GCA mean squares were several times greater than SCA mean squares for plant height, technical length, no. of basal branches/plant, seed yield, no. of seeds/capsule and 1000-seed weight. Therefore, the magnitude of additive genetic effects must be of considerable value for each character. Consequently, effective selection should be possible within these $F_2$ and subsequent populations for these traits. Regarding phenotypic and genotypic correlation coefficients among eight traits indicate that, the flax breeder must give priority to selection for increased both of plant height and no. of basal branches to increase straw yield /plant, and both of no. of capsules and 1000-seed weight to improve seed yield per plant.

Table 2. Mean Squares from ANOVA of general (GCA) and specific (SCA) combining ability of 21 flax genotypes (6 parents and 15 $F_1$'s crosses), for straw and seed yields and their components.

| S.O.V. | df | Straw yield and its components | | | | Seed yield and its components | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Straw yield / plant(g) | Plant height (cm) | Technical length (cm) | No. of basal branches | Seed yield/plant (g) | No. of capsules/plant | 1000-seed weight | No. of seeds/capsule |
| Genotypes | 20 | 27.10** | 151.61** | 136.43** | 0.85** | 3.07** | 351.88** | 9.56** | 1.73** |
| crosses( C ) | 14 | 29.54** | 109.54** | 93.48** | 1.03** | 3.12** | 358.40** | 8.20** | 1.12** |
| parents ( P) | 5 | 13.13** | 281.53** | 168.56** | 0.51* | 1.20** | 184.58** | 13.85** | 3.76** |
| P. *vs*.C | 1 | 62.70** | 90.97** | 77.25** | 0.06 | 11.73** | 1097.2** | 7.15** | 0.05 |
| GCA | 5 | 8.83** | 73.56** | 95.03** | 0.55** | 1.25** | 99.52** | 10.34** | 1.08** |
| SCA | 15 | 9.10** | 42.86** | 28.96** | 0.20** | 0.95** | 123.22** | 0.80** | 0.41** |
| Error | 40 | 0.35 | 3.82 | 3.30 | 0.06 | 0.08 | 13.74 | 0.04 | 0.06 |
| GCA/SCA ratio | | 0.97 | 1.72 | 3.28 | 2.81 | 1.32 | 0.81 | 12.91 | 2.66 |

**,*Significant at 0.05 and 0.01 levels of probability, respectively.

Table 3. Estimates of general combining ability effects ($\hat{g}_i$) for Straw and seed yields and their components in 6 flax genotypes.

| Straw yield and its components | | | | |
|---|---|---|---|---|
| Parents | Straw yield / plant(g) | Plant height (cm) | Technical length (cm) | No. of basal branches |
| $P_1$= Giza 8 | 1.678** | -0.819 | 0.214 | 0.500** |
| $P_2$= S.402/1 | -0.810** | -4.894** | -6.653** | -0.017 |
| $P_3$= S.420/140/5/11 | -1.057** | 1.264 | 1.681** | -0.183* |
| $P_4$= S.421/43/14/7 | -0.454* | 1.289* | 2.247** | -0.233** |
| $P_5$= S.533/39/5/3 | 0.831** | 4.139** | 2.681** | -0.075 |
| $P_6$= Daniela | -0.189 | -0.978 | -0.169 | 0.008 |
| LSD(gi-gi) | | | | |
| 0.05 | 0.601 | 1.974 | 1.836 | 0.252 |
| 0.01 | 0.804 | 2.642 | 2.457 | 0.337 |
| r | 0.335 | 0.867* | 0.896* | 0.617 |
| Seed yield and its components | | | | |
| Parents | Seed yield/plant (g) | No. of capsules/plant | 1000-seed weight | No. of seeds/capsule |
| $P_1$= Giza 8 | 0.458** | -0.890 | 1.645** | -0.450** |
| $P_2$= S.402/1 | 0.518** | 4.068** | 1.208** | -0.471** |
| $P_3$= S.420/140/5/11 | -0.320** | -2.390 | -0.629** | 0.217** |
| $P_4$= S.421/43/14/7 | -0.190* | -4.224** | -0.335** | 0.400** |
| $P_5$= S.533/39/5/3 | -0.062 | 4.493** | -0.878** | 0.142 |
| $P_6$= Daniela | -0.404** | -1.057 | -1.011** | 0.163* |
| LSD(gi-gi) | | | | |
| 0.05 | 0.278 | 3.746 | 0.198 | 0.240 |
| 0.01 | 0.371 | 5.012 | 0.265 | 0.321 |
| r | 0.379 | 0.438 | 0.966** | 0.983** |

*,** Significant at 0.05 and 0.01 levels of probability, respectively.
r : Simple correlation coefficients between GAC values and parental means.

Table 4. Estimates of specific combining ability ($\hat{s}_{ij}$) effects for straw, seed yields and their components in 15 flax crosses.

| Crosses | Straw yield and its components | | | | Seed yield and its components | | | |
|---|---|---|---|---|---|---|---|---|
| | Straw yield / plant(g) | Plant height (cm) | Technical length (cm) | No. of basal branches | Seed yield/plant (g) | No. of capsules/plant | 1000-seed weight | No. of seeds/capsule |
| $P_1xP_2$ $ | -1.161* | -5.775** | -4.745** | -0.064 | 0.166 | -4.176 | 0.084 | 0.626** |
| $P_1xP_3$ | 3.179** | 0.600 | -2.612 | 0.102 | 0.301 | -1.518 | 0.794** | 0.438* |
| $P_1xP_4$ | 5.570** | 4.242* | 1.621 | 0.752** | 2.064** | 20.815** | 1.691** | -0.345 |
| $P_1xP_5$ | 0.235 | 5.792** | 3.321* | -0.006 | 0.699** | 10.999** | -0.090 | -0.020 |
| $P_1xP_6$ | 0.488 | 7.375** | 6.305** | 0.111 | 0.824** | 4.182 | 0.633** | 0.626** |
| $P_2xP_3$ | -1.269* | -1.085 | 1.388 | -0.381 | 0.217 | -3.743 | 0.075 | 0.926** |
| $P_2xP_4$ | -0.142 | 2.117 | 0.688 | 0.002 | 0.343 | 6.457 | 0.098 | -0.258 |
| $P_2xP_5$ | 1.000 | 5.933** | 3.188 | 0.177 | 0.749** | 14.874** | -0.026 | -0.433* |
| $P_2xP_6$ | 1.333* | 4.450* | 6.171** | 0.561* | 0.200 | 8.657* | -0.400* | -0.354 |
| $P_3xP_4$ | -2.538** | 0.225 | 1.555 | -0.231 | -1.078** | -9.218** | -1.829** | 0.288 |
| $P_3xP_5$ | -2.503** | -12.692** | -10.15** | -0.656** | -0.486 | -6.635 | 0.517** | -0.987** |
| $P_3xP_6$ | 0.250 | 1.358 | -0.429 | -0.006 | 0.142 | 7.349* | 0.520** | -1.208** |
| $P_4xP_5$ | -2.196** | -6.383** | -1.045 | -0.473* | -0.403 | -9.435** | 0.364* | 0.070 |
| $P_4xP_6$ | 2.747** | -2.867 | -2.929 | -0.089 | -0.142 | -4.851 | 0.689** | -0.091 |
| $P_5xP_6$ | 4.472** | 8.083** | 8.171** | 0.486* | 0.497* | 5.832 | 0.076 | 0.601** |
| LSD(Sij-Sii) | | | | | | | | |
| 0.05 | 1.590 | 5.244 | 4.858 | 0.667 | 0.734 | 9.911 | 0.524 | 0.636 |
| 0.01 | 2.127 | 6.989 | 6.500 | 0.892 | 0.983 | 13.260 | 0.701 | 0.850 |
| r | 0.926** | 0.813** | 0.691** | 0.875** | 0.912** | 0.927** | 0.584** | 0.741** |

$ = Number refer to parent codes, Table 3.

*,** Significant at 0.05 and 0.01 levels of probability, respectively.

r : Simple correlation coefficients between SAC values and means of crosses.

Table 5. Mean performances of 21 flax genotypes ( 6 parents and 15 $F_1$'s crosses) for straw, seed yields and their components.

| Genotypes | Straw yield and its components | | | | Seed yield and its components | | | |
|---|---|---|---|---|---|---|---|---|
| | Straw yield / plant(g) | Plant height (cm) | Technical length (cm) | No. of basal branches | Seed yield/plant (g) | No. of capsules/plant | 1000-seed weight | No. of seeds/capsule |
| Parents | | | | | | | | |
| $P_1$= Giza 8 | 9.32 ab | 101.40 b | 76.20 b | 3.33 a | 2.10 bc | 33.63 b | 9.50 a | 6.60 b |
| $P_2$= S.402/1 | 8.62 b | 96.53 b | 61.07 d | 2.60 ab | 3.41 a | 47.67 a | 10.27 a | 6.97 b |
| $P_3$= S.420/140/5/11 | 9.45 ab | 117.47 a | 86.20 a | 3.00 ab | 3.03 ab | 52.67 a | 6.47 b | 8.87 a |
| $P_4$= S.421/43/14/7 | 7.49 b | 113.07 a | 82.27 ab | 2.33 b | 2.44 a-c | 40.23 ab | 6.59 b | 9.20 a |
| $P_5$= S.533/39/5/3 | 11.28 a | 117.07 a | 81.33 ab | 2.87 ab | 2.56 ab | 51.73 a | 5.59 c | 8.90 a |
| $P_6$= Daniela | 5.10 c | 98.00 b | 68.73 c | 2.27 b | 1.65 c | 37.87 b | 4.99 c | 8.70 a |
| Crosses | | | | | | | | |
| $P_1xP_2$ | 9.83 f-h | 97.67 g | 66.53 g | 3.20 a-c | 4.36 b | 49.57 c-f | 10.71 a | 8.20 c-f |
| P1xP3 | 13.92 bc | 110.20 b-e | 77.00 d-f | 3.20 a-c | 3.65 bc | 45.77 e-g | 9.58 b | 8.37 c-e |
| P1xP4 | 16.91 a | 113.87 a-c | 81.80 b-d | 3.80 a | 5.55 a | 66.27 ab | 10.77 a | 7.77 e-g |
| P1xP5 | 12.86 cd | 118.27 a | 83.93 a-c | 3.20 a-c | 4.31 b | 65.17 ab | 8.45 cd | 7.83 d-g |
| P1xP6 | 12.10 c-e | 114.73 ab | 84.07 ab | 3.40 ab | 4.09 bc | 52.80 c-f | 9.04 bc | 8.50 b-e |
| P2xP3 | 6.98 jk | 104.47 e-g | 74.13 ef | 2.20 de | 3.63 bc | 48.50 d-f | 8.42 cd | 8.83 a-c |
| P2xP4 | 8.71 g-j | 107.67 c-f | 74.00 ef | 2.53 b-e | 3.89 bc | 56.87 b-e | 8.74 cd | 7.83 d-g |
| P2xP5 | 11.14 d-f | 114.33 a-c | 76.93 d-f | 2.87 b-d | 4.42 b | 74.00 a | 8.07 d | 7.40 fg |
| P2xP6 | 10.45 e-g | 107.73 c-f | 77.07 d-f | 3.33 a-c | 3.53 b-d | 62.23 a-c | 7.57 de | 7.50 fg |
| P3xP4 | 6.07 k | 111.93 b-d | 83.20 a-d | 2.13 de | 1.63 f | 34.73 g | 4.98 h | 9.40 a |
| P3xP5 | 7.39 I-k | 101.87 fg | 71.93 fg | 1.87 e | 2.35 ef | 46.03 e-g | 6.78 f | 7.53 fg |
| P3xP6 | 9.12 f-I | 110.80 b-e | 78.80 c-e | 2.60 b-e | 2.63 de | 54.47 b-e | 6.65 fg | 7.33 g |
| P4xP5 | 8.30 h-j | 108.20 b-e | 81.60 cd | 2.00 de | 2.56 d-f | 41.40 fg | 6.92 ef | 8.97 a-c |
| P4xP6 | 12.22 cd | 106.60 d-f | 76.87 d-f | 2.47 c-e | 2.48 ef | 40.43 fg | 7.11 ef | 8.63 a-d |
| P5xP6 | 15.23 ab | 120.40 a | 88.40 a | 3.20 a-c | 3.25 c-e | 59.83 b-d | 5.96 g | 9.07 ab |
| Means | 10.12 | 109.16 | 77.72 | 2.78 | 3.22 | 50.57 | 7.77 | 8.21 |

The values identified by the same letter are not significantly different at 0.05 level of probability .

Table 6. Phenotypic ($r_p$) and genotypic ($r_g$) correlation coefficients among eight traits in 21 flax genotypes.

| Characters | | Straw yield / plant(g) | Plant height (cm) | Technical length (cm) | No. of basal branches | Seed yield/plant (g) | No. of capsules/ plant | 1000-seed weight |
|---|---|---|---|---|---|---|---|---|
| Plant height (cm) | rp | 0.544* | | | | | | |
| | rg | 0.661 | | | | | | |
| Technical length (cm) | rp | 0.418 | 0.913** | | | | | |
| | rg | 0.552 | 0.737 | | | | | |
| No. of basal branches | rp | 0.780** | 0.340 | 0.256 | | | | |
| | rg | 0.465 | 0.232 | 0.124 | | | | |
| Seed yield/plant (g) | rp | 0.659** | 0.235 | 0.021 | 0.649** | | | |
| | rg | 0.331 | 0.111 | -0.134 | 0.535 | | | |
| No. of capsules/plant | rp | 0.588** | 0.494* | 0.219 | 0.520* | 0.786** | | |
| | rg | 0.607 | 0.321 | -0.045 | 0.613 | 0.654 | | |
| 1000-seed weight | rp | 0.409 | -0.291 | -0.382 | 0.547* | 0.738** | 0.273 | |
| | rg | 0.214 | 0.210 | 0.211 | 0.601 | 0.667 | 0.143 | |
| No. of seeds/capsule | rp | -0.106 | 0.382 | 0.473** | -0.308 | -0.277 | -0.288 | -0.564** |
| | rg | 0.101 | -0.241 | 0.433 | 0.247 | 0.024 | 0.347 | -0.323 |

*,** Significant at 0.05 and 0.01 levels of probability, respectively.

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# تحليل الهجن الدائرية لتقدير القدرة علي الائتلاف لبعض التراكيب الوراثية في الكتان

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أجريت هذه الدراسة بهدف تقدير القدرة علي الائتلاف والفعل الجيني من خلال تقييم ١٥ هجين ناتجة من برنامج تهجينات تم إنجازه في موسم ٢٠٠٤/٢٠٠٥ وذلك بالتهجين بين ستة أباء(١= جـ٨ ، ٢= س١/٤٠٢ ، ٣= س ١١/٥/١٤٠/٤٢٠ ، ٤= س ٧/١٤/٤٣/٤٢١ ، ٥= س ٣/٥/٣٩/٥٣٣ ، ٦= دنيال ) باستعمال تحليل الهجن الدائرية . في موسم ٢٠٠٥ /٢٠٠٦ تم تقييم الـ٦ آباء مع ١٥ هجين في الجيل الأول في حقل تربية الكتان بمركز البحوث الزراعية بالجيزة في تجربة قطاعات كاملة العشوائية ذات ثلاثة مكررات.

١-تشير النتائج الخاصة بمحصول القش ومكوناته إلى أن تأثير العوامل الوراثية الغير مضيفة كانت أكثر أهميه من العوامل الوراثية المضيفة في توريث صفة محصول القش للنبات بينما العوامل الوراثية المضيفة كانت أكبر من الغير مضيفة في توريث صفات الطول الكلي والطول الفعال و عدد الأفرع القاعدية.

٢-كما تشير النتائج أن الأب س ٣/٥/٣٩/٥٣٣ أظهر قدرة عامة عالية على الائتلاف لصفات محصول القش والطول الكلي والطول الفعال كذلك الأبوين (س ٧/١٤/٤٣/٤٢١ ، س ٣/٥/٣٩/٥٣٣) لصفاتي الطول الكلي والطول الفعال مما يدل على إمكانية إدخال هذه الآباء في برنامج تربية الكتان لتحسين محصول القش للنبات.

٣-كما تشير النتائج أن الهجن (١ x٤ ، ١ x٥ ، ٥ x٦) أظهرت قدرة خاصة على الائتلاف لصفة محصول القش للنبات وأهم مكوناته وهذه الهجن أبويها (عاليxمنخفض) في القدرة العامة على الائتلاف

٤-كما تشير النتائج الخاصة بمحصول البذور ومكوناته إلى أن النسبة بين القدرة العامة والخاصة على الائتلاف إلى أن صفات محصول البذور وعدد البذور بالكبسولة ووزن الألف بذرة يتحكم في توريثها الفعل المضيف للجينات.

٥-كما تشير النتائج أن الأب س ١/٤٠٢ أظهر قدرة عامة على الائتلاف لصفات محصول البذور وعدد الكبسولات للنبات ووزن الألف بذرة بينما الأباء س ١١/٥/١٤٠/٤٢٠ ، س ٧/١٤/٤٣/٤٢١ ، دانيال أظهرت قدرة عالية على الائتلاف لصفة عدد البذور بالكبسولة .

٦-كما تشير النتائج أن هجين واحد (٢x٥) أظهر قدرة خاصة على الائتلاف لصفتي محصول البذور وعدد الكبسولات للنبات وأن هذا الهجين (عاليxعالي) أي أن أبويه يمتازان بالقدرة العامة العالية على الائتلاف لصفة عدد الكبسولات للنبات بينما (عاليxمنخفض) لصفة محصول البذور للنبات ، بينما ثلاثة هجن (١ x٤ ، ١ x٥ ، ١ x٦) أظهرت قدرة خاصة على الائتلاف لصفات محصول البذرة للنبات ومعظم مكوناته وكان أبوين كل هجين عبارة عن (عاليxمنخفض) في القدرة العامة على الائتلاف.

٧-كما تشير نتائج الارتباط الظاهري و الوراثي بين صفات محصولي القش والبذور ومكوناتهما إلى أن مربي الكتان يعطي أهميه لصفتي الطول الكلي وعدد الأفرع القاعدية عند الانتخاب لتحسين محصول القش ، وكذلك أهميه لصفتي عدد الكبسولات للنبات ووزن الألف بذرة عند الانتخاب لتحسين محصول البذور للنبات.